

AIR WAR COLLEGE

AIR UNIVERSITY

CRITICAL THINKING SKILLS OF US AIR FORCE SENIOR AND
INTERMEDIATE DEVELOPMENTAL EDUCATION STUDENTS

by

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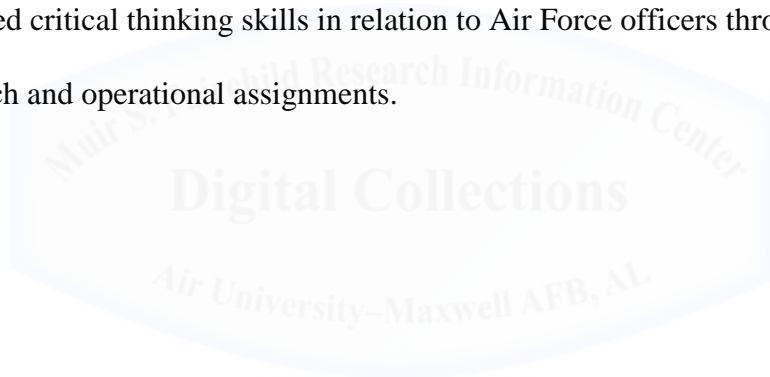
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Biography

Lieutenant Colonel Adam Stone is assigned to the Air War College, Air University, Maxwell AFB, AL. He was commissioned in 1995 from the US Air Force Academy and has served in a variety of responsibilities as a career intelligence professional. His assignments have included special operations, fighter squadron intelligence officer, fighter wing senior intelligence officer, instructor at the USAF Weapons School, squadron Director of Operations, airpower intelligence, surveillance and reconnaissance strategist for Headquarters Air Force, Squadron Commander, and Deputy Group Commander. Prior to this assignment, he served as the Executive Officer to the Commander, 25th Air Force. He earned a Doctorate of Management in 2008 and explored critical thinking skills in relation to Air Force officers through previous academic research and operational assignments.



Abstract

In their September 2015 AF Future Operating Concept, the Secretary of the Air Force and the Chief of Staff of the Air Force called for the identification of critical thinkers and metrics to track and measure critical thinking (CT) skills. To answer their charge, this quantitative research project used the Watson-Glaser Critical Thinking Appraisal to establish a baseline of current CT skills among active duty Air Force (AF) officers attending professional military education (PME) in-residence at Air Command and Staff College (ACSC), School for Advanced Air and Space Studies (SAASS), and Air War College (AWC). T-tests indicated no statistically significant difference in the CT skills of the sample of ACSC and AWC students, but did reveal a significant difference between ACSC and SAASS students. Furthermore, the average raw score for ACSC and AWC was at the 36th percentile, with SAASS at the 61st percentile, when compared to the normative group with a Master's-level education. This result established AF officers attending ACSC and AWC in-residence were below average in CT skills when compared with individuals at the same academic level. These findings suggested that the operational leadership, and, most importantly, levels of PME and education, fail to develop the CT skills of AF officers. As a partial solution to this problem, this paper will make recommendations for modifications in the delivery of PME curriculum.

Introduction

In the September 2015 Air Force Future Operating Concept (AF FOC), the Secretary of the Air Force (SecAF) and the Chief of Staff of the Air Force (CSAF) identified the need for:

...Airmen who display critical thinking in complex situations, are educated and trained appropriately, and ultimately are empowered and trusted to execute... This foundation is built by recruiting Airmen with indicated potential for critical thinking and adaptive behavior; screening for these attributes will require new metrics and forms of evaluation.¹

However, no published or publically available data exists to address (1) the current state of critical thinking (CT) skills in the Air Force (AF), (2) a recommended metric by which to measure CT skills, and (3) whether the existing state of CT skills satisfies the AF FOC's intent. Using the Watson-Glaser Critical Thinking Appraisal (WGCTA), this research addressed these points by focusing on the active duty (AD) AF students attending Air Command and Staff College (ACSC), School for Advanced Air and Space Studies (SAASS), and Air War College (AWC) in Academic Year 2016 (AY16). These three populations within Air University (AU), by virtue of the developmental education boarding process, provided a representative sample of the top 20% of AD AF officers for AY16.² The research explored the state of CT skills as an indicator for SecAF and CSAF, not whether or not, or how much, AU integrated CT into the curriculums.

Since before 1997, the AF has identified CT as a key skill,³ yet the AF has not established any metrics to provide a baseline assessment of CT in the officer corps. Several AF studies identified the need for CT, but the authors limited the recommendations to ways to improve CT programs without first assessing the state of CT skills.⁴ This foundational study, through a quantitative methodology, provided a baseline assessment of CT skills from a sample of ACSC, AWC, and SAASS students in AY16.

Thesis

This foundational study used the WGCTA to measure the CT skills of a sample of AD AF attending ACSC, SAASS, and AWC in order to establish the current baseline of CT as represented by the top 20% of AD AF officers in AY16. The research design tested the hypothesis that there was no statistically significant difference in the CT skills of IDE and SDE students. SAASS, as a more selective advanced studies program, provided an additional data point for comparison with ACSC and AWC. The research answered the following four research questions:

- What was the current state of CT skills as measured by the WGCTA?
- Using t-tests, were there any significant differences between all three schools?
- How did the sample's performance compare with a graduate degree normative group?
- What CT instructional methods could Air University apply to in-residence PME?

The results of this research provided a starting point for data-driven decision making regarding the integration of CT into PME as well as the operational AF in order to meet the AF FOC's requirements.

Literature Review

As identified in AF Doctrine Document 1-1, senior leaders expect Airmen to think critically: "education provides critical thinking skills, encouraging exploration into unknown areas and creative problem solving. Its greatest benefit comes in unknown situations or new challenges; education prepares the individual for unpredictable scenarios."⁵ The National Military Strategy (NMS) required the Department of Defense (DoD) to update how it "selects and incentivizes faculty, rewards critical thought, and promotes our most innovative minds. Continuous, demanding education inspires new ideas and identifies better ways to accomplish

our mission.”⁶ Furthermore, the NMS identified two out of six attributes of the joint leader to be “Think critically and strategically in applying joint warfighting principles and concepts to joint operations” and “Anticipate and adapt to surprise, uncertainty, and chaos.”⁷ The Planner’s Handbook for Operational Design further highlights CT “is instrumental to a sufficient understanding of the operating environment.”⁸ CT is not a panacea for the volatile, uncertain, complex, and accelerating global environment, but it provides a framework to improve analytic rigor and reduce the number of flawed decisions.

Senior leaders in the AF and DoD frequently emphasized the need for CT, but they rarely provided any refined directives defining CT skills or how these skills should be measured and delivered. This leaves implementation to either Air University or, for those not selected to attend in-residence IDE or SDE, the individual, with limited tools for execution. The following section details the challenges of defining the construct of CT, presenting a consensus that CT skills (1) are the product of a personal and life-long dedication to improving the accuracy and logic of thought patterns and (2) can be both taught and measured. Based on a comparison of CT development programs in academic and business settings, the deliberate development of CT skills in both PME and throughout the operational AF would be possible to implement.

Concept of Critical Thinking

Definitions of CT range from abstract constructs to specific measurable skills.⁹ The National Council for Excellence in CT (NCECT) approached the definition with two components: “(1) a set of information and beliefs generating and processing skills, and (2) the habit, based on intellectual commitment, of using those skills to guide behavior.”¹⁰ In comparison, Paul and Elder defined CT as: “the art of analyzing and evaluating thinking with a view to improving it.”¹¹ Vaughn provided a succinct working definition for the construct of CT:

“the systematic evaluation or formulation of beliefs or statements, by rational standards.”¹²

Watson and Glaser, the creators of the survey instrument used in this study, viewed CT as:

...a composite of attitudes, knowledge, and skills. This composite includes: (1) attitudes of inquiry that involve an ability to recognize the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true; (2) knowledge of the nature of valid inferences, abstractions, and generalizations in which the weight or accuracy of different kinds of evidence are logically determined; and (3) skills in employing and applying the above attitudes and knowledge.¹³

While even this small sample of available CT definitions provides additional and valuable insight, the focus remains on a systematic evaluation of an individual's thoughts by rational standards. Although simplistic, Vaughn's definition provides the best balance between the scope of the concept and being sufficiently succinct for use in everyday discussions around the AF.

With this foundation for the concept of CT, one can identify skills with more specificity for purposes of direct comparison. As tested in the WGCTA, Watson and Glaser delineated the five skills of CT: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments (see Table 1).

Measuring Critical Thinking

Researchers have dedicated decades of study on various methodologies measuring CT. While there are somewhat intrusive and time-intensive methods where an individual has a one-on-one examination with a trained evaluator, most researchers and organizations use standardized assessment instruments. Although multiple CT tests are available,¹⁴ the WGCTA was the most effective instrument to answer the proposed hypothesis and research questions. The WGCTA is computer administered and has established validity and reliability, as well as normative groups based on a wide range of populations.¹⁵ The WGCTA assesses the 5 CT skills through 40 multiple-choice items. Published research relying on the WGCTA is abundant,

Table 1. Definitions of WGCTA Skills

Critical Thinking Skill	Definition
1. Inference	Discriminating among degrees of truth or falsity of inferences drawn from given data
2. Recognition of Assumptions	Recognizing unstated assumptions or presuppositions in given statements or assertions
3. Deduction	Determining whether certain conclusions necessarily follow from information in given statements or premises
4. Interpretation	Weighing evidence and deciding if generalizations or conclusions based on the given data are warranted
5. Evaluation of Arguments	Distinguishing between arguments that are strong and relevant and those that are weak or irrelevant to a particular question at issue

Source: Data adapted from Goodwin Watson & Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual* (San Antonio, TX: Psychological Corporation, 1980), 2.

addressing the importance of CT in career fields to include emergency management, nursing, education, and intelligence.¹⁶

While the WGCTA itself is broken into the five CT skills, the individual test results yield three categories: (1) recognize assumptions, (2) evaluate arguments, and (3) draw conclusions. Factor analysis revealed a more repeatable and reliable assessment by combining inference, deduction, and interpretation into the category of draw conclusions. As a new category not defined in Table 1, drawing conclusions is the act of “arriving at conclusions that logically follow from the available evidence.”¹⁷

Professional literature as well as the research reported in the test manual established the psychometric qualities of reliability and validity for the WGCTA.¹⁸ For internal consistency reliability coefficients and Standard Errors of Measurement, the WGCTA scored a 0.83 and 2.63, respectively.¹⁹ The two versions of the WGCTA available for pre- and post-testing options in

educational and developmental programs provided split-half reliability as well. Watson and Glaser examined the WGCTA's validity in several settings with different populations. Despite the various definitions of CT, students at various levels and across several lines of study performed on the WGCTA in a manner to lend criterion validity to the multiple attempts to develop CT skills in any environment.²⁰ Watson and Glaser assessed the construct validity, including content validity, internal factor structure, and convergent and discriminate validity, with supportive results.²¹ The established psychometric qualities of the WGCTA make it a useful measuring instrument for research and for programs exploring the development of CT.

Given the amount of time and research required to create and validate a survey instrument, the military should use an existing tool in order to measure CT.²² The AF must remember the WGCTA is a single assessment, and is not suitable as the sole metric for identifying critical thinkers. Some critical thinkers will possess different modalities of thinking that does not effectively translate to the WGCTA's measurement. As with any assessment of Airmen, the AF must consider the supervisor's assessment and the individual's performance.

Improving Critical Thinking

Upon measuring CT in a population, several participants will likely want to explore different ways to improve those skills. This is a legitimate endeavor for all Airmen as CT skills are not static.²³ One study comparing the development of CT skills across different age groups found that, "adult students do not appear to be dramatically different from their younger counterparts in terms of their reflective thinking, including their epistemic assumptions and the way they justify their beliefs in the face of uncertainty."²⁴ The development of CT should not be limited to just the brand-new officers and enlisted on the flightline nor to the strategic-level thinkers in the Pentagon.

The importance of selecting the right faculty. When creating a CT program, the organization must know which individuals are critical thinkers before determining the faculty. Magnussen's research in a nursing program suggested the CT skills of graduating students correlated with the CT skills of the instructors, even to the point of fault.²⁵ Students with low scores improved to approximate the instructors' CT scores and students with scores already similar to the faculty remained roughly the same. The worrying portion of the research was the fact that the students initially scoring high in CT skills dropped and became average through the course of the multi-year program. Per Blondy, significantly higher CT skills for a nursing school faculty, when compared to the students, was critical to the success of CT development.²⁶ In a similar study, there were parallel themes in the difference of CT skills between uniformed police and police cadets.²⁷ Finally, tutors in a successful WGCTA test preparation program for teachers scored significantly higher than the students did.²⁸ The significant differences between the instructor and student scores in these studies suggested a successful program requires a faculty with strong CT skills, and additional research conducted as part of this project suggested the talent for a successful program was already in existence at AU (see Implications).

The flexibility of the human mind. CT is not a static item such as one's intelligence quotient. Instead, people can improve CT skills at any age.²⁹ Conversely, CT skills are also perishable and can deteriorate if the individual does not dedicate oneself to the maintenance and improvement over time.³⁰ Kegan and Lahey took a comprehensive approach to the development of the adult mind, including CT, and identified three general plateaus for adults: (1) socialized mind, (2) self-authoring mind, and (3) self-transforming mind.³¹ The socialized mind is where most people spend their lives, capable of engaging in conversation and arguments. The self-authoring mind is able to accumulate new information from a variety of sources and build new

approaches to various challenges by examining the existing processes. While somewhat easy to attain for most people, this still requires continued effort to stay on this plateau and not regress to the socialized mind when external pressures, such as a deadline, approach. The self-transforming mind constantly seeks new ways to solve problems that others may not even realize exist. Few will ever reach this highest level and those that do must constantly strive to remain on that plateau.³² While Kegan and Lahey's theory was more expansive than CT alone, it indicated the fluid nature of one's comfort with mental complexity.

Focusing specifically on CT, Reed explored the potential to develop CT skills, concluding, "students in the experimental group performed at a statistically significantly higher level than students in the control group."³³ Reed found both younger (less than age 22) and older (over age 22) students benefitted equally from CT training. As a complement to Moore's research³⁴ indicating life experience does not necessarily directly correlate with improved CT skills, Reed found that "age and gender do not appear to play significant roles in developing college students' critical thinking abilities."³⁵ Peerbolte studied the CT skills of disaster management professionals, finding "no correlation between a participant's score and the dependent variables of age and gender...but positive correlation between a participant's score and the independent variables of years of education and years in occupation."³⁶

The AF mission requires personnel capable of recognizing personal thought processes and making structured and reasoned analysis to reach decisions. Research supports that the AF can purposely develop CT, meeting the AF FOC's requirements.³⁷ Programs supporting CT development already existed around the AF in limited capacity, but these programs were typically limited to a particular set of career fields.³⁸ A structured holistic approach will be critical to integrate CT improvement programs into several forms of PME, both officer and

enlisted. In building CT into PME curriculum, it would be desirable to measure CT objectively through a validated survey instrument and to educate faculty and mentors on educational processes for fostering CT skills.

Considerations when building the critical thinking program. Multiple programs already existed across academia to build CT skills in various disciplines such as organization leadership and nursing, with several organizations publishing outlines of the training programs as well as results. Elder and Paul insisted critical thinkers must “routinely apply intellectual standards to the elements of reasoning in order to develop intellectual traits.”³⁹ Kiltz further elaborated with the assessment “to develop critical thinking skills, students must be active learners in the learning process and they must be required to identify and solve unstructured problems using multiple information sources.”⁴⁰ Paul and Elder even identified 10 intellectual standards, 8 elements of reasoning, and 8 intellectual traits, ultimately developing 35 dimensions of critical thought.⁴¹ In essence, the AF needs to apply structured problem solving at PME in order to develop CT, generating warfighters able to operate effectively in an ambiguous environment.

The National Council for Excellence in CT (NCECT) has provided tailored CT development programs to schools and businesses for over 30 years. Emphasizing the need for long-term sustained development of CT, business programs tended to consist of five two-day seminars covering the topics of (1) recognizing the importance of CT, (2) using the tools of CT to make better decisions, (3) understanding the barriers to CT, (4) learning the art of analysis, and (5) learning the art of assessing thought.⁴² The program “clarif[ies] what is meant by the concept of critical thinking and develop[s] practical ways to infuse critical thought into our professional work both individually and institutionally.”⁴³ NCECT’s website offered additional

course structures for consideration in either building an organization's own CT program or hiring a team to visit the site and conduct the training.

Based on various searches through the AU portal as well as ProQuest and EBSCOhost, very limited publically available information suggested possible CT programs for implementation across the Air Force.⁴⁴ One guide for the importance of CT skills in students tried to provide a lesson plan for academic instructors at Maxwell Air Force Base, Alabama to build CT awareness; however, this 2008 guide only reviewed a basic definition of CT before discussing Bloom's taxonomy and presenting a case study.⁴⁵ In short, the guide was only an introduction and insufficient for the development of CT skills. The Army shared the concern of poor development in CT skills and claimed CT was a vital component of effective mission command.⁴⁶ Likewise, the Army review of PME did not reveal programs specifically designed to develop CT skills. Although the AF repeatedly recognized the need for CT development, no single program existed that supported a sustained education as detailed by NCECT.

Understanding the concept of CT and the composite skills does not effectively transition to a general awareness of an individual's flawed decision-making. Convincing Airmen that they need to improve their methods and models is a difficult task. People will typically "remain convinced that what they are doing is satisfactory. Further, outsiders who attempt to induce change face opposition because employees presume that external consultants are arrogant in suggesting that things are not right, and that change is needed."⁴⁷ Considering potential application through PME, Paul discovered three disturbing trends in an assessment of CT across multiple civilian educational institutions:

- (1) Most college faculty at all levels lack a substantive concept of critical thinking.
- (2) Most college faculty [do not] realize that they lack a substantive concept of critical thinking, believe that they sufficiently understand it, and assume they are already teaching students it.

- (3) Lecture, rote memorization, and (largely ineffective) short-term study habits are still the norm in college instruction and learning today.⁴⁸

A successful CT development program will require senior leadership's understanding and continued support.

In summary, CT is an obvious fit with PME and the operational AF as it is about problem solving in ambiguous situations. McKown's 1997 ACSC study, the first publically available Air University product exploring CT, ultimately concluded that "innovative problem solving, critical analytical thought and sound professional judgment have been and will continue to be keys in our military leadership achieving battlespace dominance."⁴⁹ PME offers unique opportunities in that Airmen participate in various forms of in-residence and distance learning programs at multiple points across a career.⁵⁰ CT cannot just be a matter of an introductory course at the first PME, but be integrated intentionally throughout the PME curriculum in a holistic fashion. Finally, the AF should assess CT, both frequently and formally, throughout PME to determine whether the programs are effective.

Methodology

The purpose of the research was to identify the current state of CT skills among ACSC, SAASS, and AWC students in order to create a baseline, and, using a series of t-tests, determine any statistically significant differences between the three samples of students. This chapter covers the details of the populations used for the study, data collection, and data analysis.

Population and Sample

The intended population was AD AF officers, field grade or above, with AD AF residence students attending ACSC, SAASS, and AWC population during AY16 serving as a convenience sample.⁵¹ The AF sends officers to schools such as ACSC and AWC if the officers' records are in the top 20% of a given year group. SAASS is a highly competitive advanced

studies program available to officers as they complete an IDE program, such as ACSC. The three schools do not screen for CT skills specifically as consideration for attendance. The research design sampled the students when they were between three and four months into the academic programs. Conducting data collection this far into a 1-year program precluded the option of a pre-test and post-test assessment, exploring whether the schools developed CT skills within the course of the year. The schools' curriculums convey fundamental concepts of CT; however, none of the schools has specific programs or courses designed specifically to build CT skills. While the results of this study can only be generalized to the top 20% of AD AF officers, the lack of any CT screening as a prerequisite would suggest that the rest of the AD AF officer population would likely have the same or lower average scores, but not higher.⁵²

ACSC and SAASS students participated in the study on a strictly voluntary basis. While highly encouraged, AWC student participation was also voluntary. Due to the small size and heavy workload of SAASS, the Dean solicited volunteers who then received the link to take the appraisal at their convenience. The researcher selected potential participants from ACSC and AWC through a simple random sampling with replacement⁵³ and reclaimed expired instruments as individuals chose not to take the assessment. The researcher conducted three rounds of data collection for ACSC and two rounds of data for AWC in order to collect a sufficient sample.

Results

A total of 133 students participated in the research across the three schools. Table 2 depicts the participation in detail. The research compared the independent variable of school affiliation (ACSC, SAASS, or AWC) to determine if there were statistically significant differences in the WGCTA scores across the three populations as well as the overall score. The research design applied descriptive statistics and t-tests to analyze the data. Table 3 identifies the

Table 2. Participation by School

	AD AF Population	AD AF Participants	% of Participation
ACSC	295	82	28%
SAASS	36	13	36%
AWC	92	38	41%
Total	423	133	31%

mean, standard deviation, percentile ranking, as well as minimum and maximum scores for each school. The percentile ranking was a comparison between the scores of the population compared to the graduate degree normative group, consisting of “working adults from various industries, occupations, and organizational levels who share a common level of completed education...the samples are not limited to students or recent graduates.”⁵⁴ The graduate degree normative group consisted of 2,321 participants ranging across 38 occupations to include entry-level positions, government service, and executive leadership.⁵⁵

Table 3. WGCTA Descriptive Statistics

	Mean	Standard Deviation	Percentile	Minimum Score	Maximum Score
ACSC	27.07	6.100	36	13	38
SAASS	30.92	4.958	61	21	36
AWC	27.42	6.664	36	13	38

The t-test is an inferential statistical test “used to determine whether two means are significantly different at a selected probability level.”⁵⁶ The t-tests explored any differences between (1) ACSC and AWC, (2) ACSC and SAASS, and (3) AWC and SAASS. While there were several small differences between the results of the three schools, only the difference between ACSC and SAASS was statistically significant based on a probability level of 0.05. The abbreviated results for all three t-tests are in table 4 and the full t-test results are in appendix A.

Table 4. Abbreviated Results of T-Tests for ACSC, SAASS, and AWC WGCTA Scores

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	T	Sig. (2- tailed)	Mean Difference	Std. Error Difference
Comparisons	ACSC - AWC	.076	.783	-.282	.778	-.348	1.233
	ACSC - SAASS	1.152	.286	-2.162	.033	-3.850	1.781
	AWC - SAASS	1.087	.302	-1.733	.089	-3.502	2.021

Note: difference considered significant if it fell below the .05 threshold in the grey column.

The results as plotted on a histogram (see Figure 1) suggested an even distribution without significant kurtosis but with a slightly negative skew.⁵⁷ As identified in Table 3, ACSC and AWC had very similar mean scores, min and max scores, and standard deviations. SAASS had a higher mean score, less range between the min and max scores, and the smallest standard deviations among the three schools.

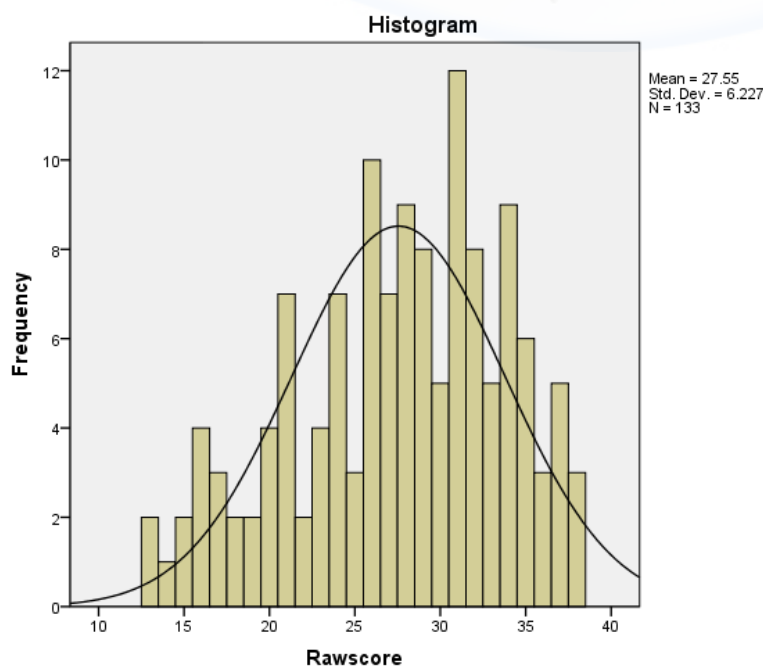


Figure 1: Distribution of raw WGCTA scores for ACSC, SAASS, and AWC (combined).

Discussion

Applying t-tests and basic descriptive statistics, the data supported the hypothesis that there was no statistically significant difference in the CT skills of AD AF students attending the in-residence ACSC and AWC programs in AY16. More specifically, there was no statistically significant difference between the total scores or across the three individual skills of (1) recognizing assumptions, (2) evaluating arguments, and (3) drawing conclusions. However, SAASS scored significantly higher than ACSC per the t-test and reflected the smallest standard deviation across the schools. The results plotted as a normal distribution without noteworthy kurtosis and a slight negative skew. The average score of the ACSC and AWC students ranked at the 36th percentile when compared to the graduate degree normative group.

Implications

In accordance with the AF FOC, CT is vitally important to the success of the AF. ACSC and AWC are a sample of the top 20% of officers by their very selection to attend IDE or SDE in-residence. The analysis indicated the top 20% of AF officers at the FGO-level were below average critical thinkers and were not naturally improving over time because of any educational, leadership, or operational experiences. The methodology presented provides the AF and DoD with a way to quantitatively measure CT, establish a baseline for military personnel, and implement an educational program where improvements in CT can be clearly measured and sustained. This research does not stop with the small portion of the AF surveyed in the research. Additional research must begin building the CT skills of the junior enlisted and officers executing the tactical mission. The AF cannot afford to consider CT as an expectation or privilege for the senior leadership, it is vital for every Airman to begin or continue the life-long pursuit of being a critical thinker.

Successful CT programs require strong critical thinkers on the faculty. Although not a sufficient sample size, six CT enthusiasts from AU faculty and leadership volunteered to take the WGCTA as well. The average raw score for all participants was 31.67; however, when considering the possibility of building a CT program, the lower 2 scores of 25 and 27 would be excluded, resulting in an average raw score for the remaining 4 of 34.5. The new average placed the 4 participants in the 86th percentile, higher than that observed with the SAASS students, and suggested the talent was already in place to enhance CT integration for all three schools. These numbers only indicated a potential, and a more complete assessment will be required before identifying the right personnel to build a CT development program.

Based on the literature review and the results, the AF needs to implement a CT development program, starting with faculty at ACSC and AWC. This will require first identifying the strongest critical thinkers as assessed by the WGCTA, giving them the time and resources to create a modified series of seminars derived from the NCECT's recommended program, and then begin sessions with all ACSC and AWC faculty to improve CT over a 3-month period with quarterly sessions thereafter. The next phase will entail applying those skills to the in-class discussions through a combination of integrating the faculty program materials into the instruction and weaving measurable CT requirements into the syllabi by modifying existing case studies and exercises in-line with Kiltz's observations.⁵⁸ CT should not be a stand-alone block of instruction early in the academic year, but a periodic and recurring enhancement throughout the program. The faculty should make their CT development program available to the rest of the AF as a baseline and the graduates will take their CT skills out to the operational AF, holding their personnel accountable to higher standards and further integrating CT. For AWC and ACSC, the recommended program is not a matter of determining what material to remove

from the courses in order to accommodate a CT program. Rather, it is how to improve the delivery of the existing materials in a manner that fosters CT development.

Areas for Further Research

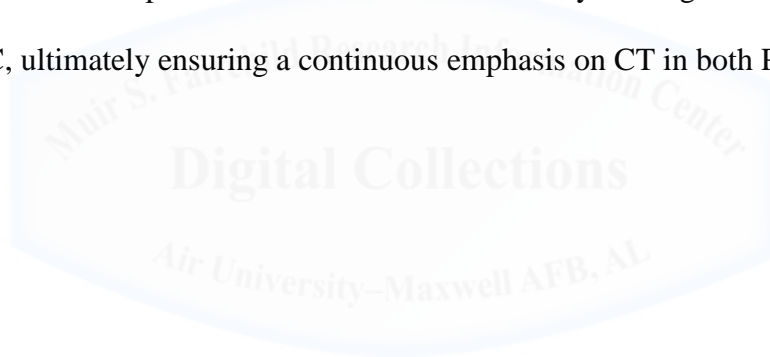
To explore whether or not PME improves CT, an additional study can survey the AD AF populations that graduated from AWC in AY15 as well as the inbound class of AY17. With the complete lack of significant difference between ACSC and AWC, coupled with previous analysis between junior and mid-level AF intelligence officers,⁵⁹ additional research could explore whether the CT skills of Squadron Officer School students or even accessions and technical school students score any differently. Such a project would be the first study expanding beyond a boarded population and would provide a baseline for the general AF population. A longitudinal study to track accessions throughout a career would be a very valuable and pure comparison, but would admittedly be very difficult to execute. The AU Command Chief reinforced the AF FOC and recommended the AF should ensure *all* Airmen, including the enlisted 80% of the force, have the tools to refine their CT skills continuously.⁶⁰ For all of the recommended studies above, future research should collect additional demographic data to look for additional trends to include AFSC, level of education, schools attended (e.g., brick and mortar, on-line, night school), and degrees held. Complementing these quantitative studies, qualitative research should explore opportunities to integrate CT into PME more effectively, both officer and enlisted, and identify specific methods to integrate CT into the operational AF.

Conclusion

AD AF students attending ACSC and AWC during AY2016 collectively scored at the 36th percentile when compared to the graduate degree normative group. This supported the

hypothesis that there was no statistically significant difference between the CT skills of ACSC and AWC AD AF students. Through a series of t-tests, SAASS participants displayed a statistically significant improvement in scores than ACSC, but there was no significant difference between AWC and SAASS.

This research was the first of its kind, establishing a baseline against which the AF could assess the current state of CT skills among AD AF officers. The methodology was also exportable to the rest of DoD for other services determined to identify and build critical thinkers. Interested organizations in the AF can also apply the methodology to examine the development of CT skills over time, identify best practices, and continue to refine the organization's approach. The AF can measure and improve CT skills across the force by starting with a faculty program at ACSC and AWC, ultimately ensuring a continuous emphasis on CT in both PME and the operational AF.



Appendix A – T-Test Results for ACSC, SAASS, and AWC

T-Test Results for ACSC and AWC

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.076	.783	-.282	118	.778	-.348	1.233	-2.789	2.093
Equal variances not assumed			-.273	66.711	.786	-.348	1.274	-2.891	2.195

T-Test Results for ACSC and SAASS

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.152	.286	-2.162	93	.033	-3.850	1.781	-7.386	-.314
Equal variances not assumed			-2.514	18.295	.021	-3.850	1.531	-7.063	-.637

T-Test Results for AWC and SAASS

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.087	.302	-1.733	49	.089	-3.502	2.021	-7.563	.559
Equal variances not assumed			-2.002	27.958	.055	-3.502	1.749	-7.085	.081

Note: refer to “equal variances assumed” row for all three tests. All data processed using SPSS v16.

Notes

1. *Air Force Future Operating Concept: A View of the Air Force in 2035*, September 2015, 12.
2. Lt Gen Steven L. Kwast, "Welcome to the Air University," Air University homepage, accessed 27 September 2015, <http://www.au.af.mil/au/>. AU provided an excellent point of departure with the stated goal to "cultivat[e] adaptive, critical thinkers...crucial to security, both here and abroad."
3. Lyndon McKown, "Improving Leadership through Better Decision Making: Fostering Critical Thinking" (master's thesis, Air Command and Staff College, 1997); George Emilio, "Promoting Critical Thinking in Professional Military Education" (master's thesis, Air Command and Staff College, 2000), 2
4. George Emilio, "Promoting Critical Thinking in Professional Military Education"; Lyndon McKown, "Improving Leadership through Better Decision Making: Fostering Critical Thinking"; David T. Moore, *Critical Thinking and Intelligence Analysis* (Washington, DC: Joint Military Intelligence College, 2006).
5. Air Force Doctrine Document 1-1, *Leadership and Force Development*, 8 November 2011, 39, http://static.e-publishing.af.mil/production/1/af_cv/publication/afdd1-1/afdd1-1.pdf.
6. *The National Military Strategy of the United States 2015*, June 2015, 14, http://www.jcs.mil/Portals/36/Documents/Publications/2015_National_Military_Strategy.pdf.
7. *The National Military Strategy of the United States 2015*, 14, http://www.jcs.mil/Portals/36/Documents/Publications/2015_National_Military_Strategy.pdf.
8. Joint Staff, J-7, *Planner's Handbook for Operational Design version 1.0*, 7 October 2011, V-1, http://dtic.mil/doctrine/doctrine/jwfc/opdesign_hbk.pdf.
9. Lyndon McKown, "Improving Leadership through Better Decision Making," 5-9; David T. Moore, *Critical Thinking and Intelligence Analysis*, 8-14.
10. National Council for Excellence in Critical Thinking, "Defining Critical Thinking," accessed 22 January 2016, <http://www.criticalthinking.org/pages/defining-critical-thinking/766>.
11. Richard Paul and Linda Elder, *The Miniature Guide to Critical Thinking Concepts and Tools*, 4th Edition (Dillon Bay, CA: The Foundation for Critical Thinking, 2004), 4.
12. Lewis Vaughn, *The Power of Critical Thinking: Effective Reasoning about Ordinary and Extraordinary Claims* (New York: Oxford University Press, 2005), 4.
13. Goodwin Watson & Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual* (San Antonio, TX: Psychological Corporation, 1980), 1.
14. For example: (1) the Cornell Critical Thinking Test, (2) the Ennis-Weir Critical Thinking Essay Test, (3) the New Jersey Test of Reasoning Skills, (4) the California Critical Thinking Skills Test, and (5) the WGCTA.
15. Roxanne Fall, "Intuitive Abilities: A Comparison between Police and Non-Police Individuals" (PhD diss., The Union Institute Graduate College, 2002), 36; Goodwin Watson & Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual*, 10-13.
16. Linda Kiltz, "Developing Critical Thinking Skills in Homeland Security and Emergency Management Courses," *Journal of Homeland Security and Emergency Management*, 6, issue 1, article 36 (January 2009), DOI: 10.2202/1547-7355.1558; Peter Behrens, "The

- Watson-Glaser Critical Thinking Appraisal and Academic Performance of Diploma School Students,” *Journal of Nursing Education* 35, no. 1 (January 1996); María E. Valdés-Corbeil, “The Effect of the Watson-Glaser Critical Thinking Appraisal Test Preparation Program on the Critical Thinking of Teacher Education Program Applicants,” (PhD diss., University of Houston, 2005); Adam J. Stone, “Critical Thinking Skills of Air Force Intelligence Officers: Are We Developing Better Critical Thinkers?” (master’s thesis, National Defense Intelligence College, 2008).
17. Goodwin Watson & Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual*, 4.
 18. Ibid., 10; Bernadette Gadzella et al., “Reliability and Validity of the Watson-Glaser Critical Thinking Appraisal-Forms for Different Academic Groups,” *Journal of Instructional Psychology* 33, no. 2 (June 2006); Diane Wilson & Edwin Wagner, “The Watson-Glaser Critical Thinking Appraisal as a Predictor of Performance in a Critical Thinking Course,” *Educational and Psychological Measurement* 41 (1981); Robert Loo & Karran Thorpe, “A Psychometric Investigation of Scores on the Watson-Glaser Critical Thinking Appraisal New Form S,” *Educational and Psychological Measurement* 59, no. 6 (December 1999).
 19. Goodwin Watson & Edward M. Glaser, *Watson-Glaser II Critical Thinking Appraisal: Technical Manual and User’s Guide* (Bloomington, MN: NCS Pearson, Inc, 2010), 18.
 20. Bernadette Gadzella et al., “Reliability and Validity of the Watson-Glaser Critical Thinking Appraisal-Forms for Different Academic Groups,” 141; Goodwin Watson & Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual*, 10-11.
 21. Goodwin Watson & Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual*, 20.
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 23. Richard Paul and Linda Elder, *The Miniature Guide to Critical Thinking Concepts and Tools*.
 24. Jennifer Reed, “Effect of a Model for Critical Thinking on Student Achievement in Primary Source Document Analysis and Interpretation, Argumentative Reasoning, Critical Thinking Dispositions, and History Content in a Community College History Course” (PhD diss., University of South Florida, 1998), 38.
 25. Lois Magnussen, Dianne Ishida & Joanne Itano, “The Impact of the Use of Inquiry-Based Learning as a Teaching Methodology on the Development of Critical Thinking,” *Journal of Nursing Education* 39, no. 8 (November 2000): 360.
 26. Laurie Blondy, “A Correlational Study Between the Critical Thinking Skills of Nursing Faculty and Their Perceived Barriers to Teaching Critical Thinking Skills to Nursing Students” (PhD diss., Capella University, 2007), 84.
 27. Roxanne Fall, “Intuitive Abilities: A Comparison between Police and Non-Police Individuals,” 64.
 28. María Valdés-Corbeil, “The Effect of the Watson-Glaser Critical Thinking Appraisal Test Preparation Program on the Critical Thinking of Teacher Education Program Applicants,” 91.
 29. Richard Paul and Linda Elder, *The Miniature Guide to Critical Thinking Concepts and Tools*.

30. Ibid.
31. Robert Kegan and Lisa Lahey, *Immunity to Change: How to Overcome it and Unlock the Potential in Yourself and your Organization* (Cambridge, MA: Harvard Business Review Press, 2009).
32. Ibid.
33. Jennifer Reed, "Effect of a Model for Critical Thinking on Student Achievement in Primary Source Document Analysis and Interpretation, Argumentative Reasoning, Critical Thinking Dispositions, and History Content in a Community College History Course," 143.
34. David T. Moore, *Critical Thinking and Intelligence Analysis*.
35. Jennifer Reed, "Effect of a Model for Critical Thinking on Student Achievement in Primary Source Document Analysis and Interpretation, Argumentative Reasoning, Critical Thinking Dispositions, and History Content in a Community College History Course," 160.
36. Stacy L. Peerbolte, "Disaster management and the critical thinking skills of local emergency managers: correlations with age, gender, education, and years in occupation" *Disasters* 37(1) (2013), DOI: 10.1111/j.1467-7717.2012.01291.x: 58.
37. *Air Force Future Operating Concept: A View of the Air Force in 2035*.
38. George Emilio, "Promoting Critical Thinking in Professional Military Education," 23-25; David T. Moore, *Critical Thinking and Intelligence Analysis*, 65. Also reference the advanced analysis mobile training team provided for DoD intelligence professionals and run by Dr. Jon Kimminau in AF/A2D.
39. Linda Elder & Richard Paul, *Intellectual Standards: The Words that Name them and the Criteria that Define them* (Dillon Beach, CA: Foundation for Critical Thinking Press, 2008), 60.
40. Linda Kiltz, "Developing Critical Thinking Skills in Homeland Security and Emergency Management Courses," *Journal of Homeland Security and Emergency Management*, 5.
41. Linda Elder & Richard Paul, *Intellectual Standards: The Words that Name them and the Criteria that Define them*.
42. National Council for Excellence in Critical Thinking, "Professional Development Workshops," accessed 22 January 2016, <http://www.criticalthinking.org/pages/professional-development-workshops-for-business-professional-groups/430>.
43. Ibid.
44. AU Portal search looked for any paper with "critical thinking" in the title. Only three papers exist and the most recent was from 2003. For ProQuest, search focused on any dissertation with "critical thinking" in the title, yielding 32 dissertations meeting the criteria and no dissertation studied the military. In EBSCOhost, search focused on any scholarly journal with "critical thinking" in the title from the Academic Search Premier, Military & Government Collection, and Teacher Reference Center databases. The search yielded 480 results addressing challenges across several different career fields; however, when further limiting the search to any document with "critical thinking" in the title and "military" in the abstract, the search yielded two articles, one focusing on Army medicine and the other focusing on Army Decision Support Red Teams. Follow-on searches

- substituted each of the services for “military” and yielded no results except for the two already identified for the Army.
45. Evelyn Bean and Houston Markham, “A Mini-Guide for Teaching Critical Thinking,” Ira C. Eaker College for Professional Development, Air University, 2008.
http://www.au.af.mil/au/awc/awcgate/eaker/teaching_critical_thinking.pdf
 46. Colonel Thomas M. Williams, “Education for Critical Thinking” *Military Review* (January-February 2013),
http://usacac.army.mil/CAC2/MilitaryReview/Archives/English/MilitaryReview_20130228_art011.pdf.
 47. David T. Moore, *Critical Thinking and Intelligence Analysis*, 74.
 48. Richard Paul, Linda Elder, and T. Bartell. “California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations,” *California Commission on Teacher Credentialing* (1997). For further context, also see Richard Paul’s “The State of Critical Thinking Today,” *New Directions for Community Colleges* 2005, issue 130 (14 June 2005), <http://www.criticalthinking.org/pages/the-state-of-critical-thinking-today/523>.
 49. Lyndon McKown, “Improving Leadership through Better Decision Making: Fostering Critical Thinking,” 37.
 50. For example: accession, Squadron Officer School, ACSC, and AWC for officers and Basic Military Training, First-Term Airman’s Course, Airman Leadership School, Non-Commissioned Officer (NCO) Academy, and Senior NCO Academy for enlisted.
 51. The research did not collect data on the guard, reserve, joint, inter-agency, or international fellows at the schools because the potential sample was insufficient for generalizing to a larger population as well as the challenge of scoping the research. Likewise, the research did not collect additional demographic data regarding career field or sources of previous education because the large number of career fields would prevent any accurate correlations and the previous education consideration was beyond the scope of this foundational study.
 52. Adam J. Stone, “Critical Thinking Skills of Air Force Intelligence Officers: Are We Developing Better Critical Thinkers?” In this study, a similar methodology using the WGCTA and comparing to same normative group showed both 2LTs going through intelligence officer pipeline course and senior Captains and junior Majors going through the Intelligence Master Skills Course had no statistically significant difference in their CT skills as measured by t-test nor were there any reportable results using a Pearson’s *r* to detect any improvement in CT skills based on age. Furthermore, the two samples scored at the 35th percentile when compared to the Graduate degree norm group. Although this study was unclassified, the National Intelligence University posts all papers on their TS/SCI JWICS page regardless of classification. If interested in the details of the research, contact the author directly at adam.stone@us.af.mil.
 53. The researcher obtained lists of AD AF students, in alphabetical order, attending ACSC and AWC and then provided the e-mail address of every third name to the TalentLens point of contact to send the survey instrument link. When the 12-day period to take the appraisal expired, the researcher coordinated with TalentLens to reclaim expired surveys and start over from the top of the list, again selecting every third name, until a sufficient sample was collected.

54. Goodwin Watson & Edward M. Glaser, *Watson-Glaser II Forms D & E Critical Thinking Appraisal: Norms Composition Tables* (Bloomington, MN: NCS Pearson, Inc, 2014), 8.
55. Ibid., 8-9.
56. L.R. Gay & Peter Airasian, *Educational Research: Competencies for Analysis and Applications*, 7th ed. (Upper Saddle River, NJ: Prentice Hall, 2003), 457.
57. Figure 1 only displayed the distribution for the entire sample; however, plotting the distribution for the individual schools did not generate any significant visible differences in the normal distribution, kurtosis, or skewness.
58. National Council for Excellence in Critical Thinking, "Professional Development Workshops."; Linda Kiltz, "Developing Critical Thinking Skills in Homeland Security and Emergency Management Courses."
59. Adam J. Stone, "Critical Thinking Skills of Air Force Intelligence Officers: Are We Developing Better Critical Thinkers?"
60. CMSgt Timothy B. Horn, interview by the author, 4 December 2015.



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